
DEPARTMENT OF THE NAVY NFGS-09980C
NAVAL FACILITIES 30 September 1999
ENGINEERING COMMAND -----
GUIDE SPECIFICATION Superseding NFGS-09980B (09/98)

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09980

INTERIOR LINING FOR CONCRETE STORAGE TANKS (FOR PETROLEUM FUELS)

09/99

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 MATERIAL SAFETY
- 1.4 QUALITY ASSURANCE
 - 1.4.1 Test Reports
 - 1.4.1.1 Naval Research Laboratory (NRL) Lining Materials Tests
 - 1.4.1.2 Blasting Abrasive Tests

PART 2 PRODUCTS

- 2.1 BRAND NAME PRODUCTS
- 2.2 CONCRETE REPAIR MATERIALS
 - 2.2.1 Cement
 - 2.2.2 Abrasive
 - 2.2.2.1 New Abrasive
 - 2.2.2.2 Recycled Abrasive
 - 2.2.3 Water
 - 2.2.4 Mortar
- 2.3 EPOXY PRIMER MIXTURE
 - 2.3.1 Products for Epoxy Primer
- 2.4 NRL FORMULATION TLL-46
 - 2.4.1 Polysulfide Latex, WD-6
 - 2.4.2 Hydroxypropyl Methyl Cellulose
 - 2.4.3 Vinylidene Chloride Copolymer Latex
 - 2.4.4 Diethylene Glycol Monoethyl Ether Acetate
 - 2.4.5 2-N-Octyl-4-Isothiazolin-3-One
- 2.5 INSTRUCTIONS FOR MIXING NRL FORMULATION TLL-46
 - 2.5.1 Thickener
 - 2.5.2 Latex Lining
- 2.6 REINFORCING FABRIC
- 2.7 EPOXY COATING FOR MISCELLANEOUS METAL
- 2.8 SOURCE QUALITY CONTROL
 - 2.8.1 Sampling

2.8.2 Tests

PART 3 EXECUTION

- 3.1 PROTECTION FROM TOXIC AND HAZARDOUS CHEMICAL AGENTS
 - 3.1.1 Certified Industrial Hygienist (CIH)
- 3.2 VENTILATION AND AMBIENT CONDITIONS
- 3.3 TANK CLEANING SAFETY, FUEL REMOVAL, AND SAFETY AFTER CLEANING
- 3.4 SURFACE PREPARATION
 - 3.4.1 First Abrasive Blast
 - 3.4.2 Concrete Repairs
 - 3.4.2.1 Estimated Area
 - 3.4.3 Cove and Corner Chamfering
 - 3.4.4 Patch Tests
 - 3.4.4.1 General
 - 3.4.4.2 Test Preparation
 - 3.4.4.3 Tests
 - 3.4.4.4 Approval
 - 3.4.5 Second "Brush" Abrasive Blast
 - 3.4.6 Disposal of Used Abrasive
- 3.5 TANK LINING
 - 3.5.1 Epoxy Primer
 - 3.5.2 Latex Blend Lining System Application
 - 3.5.2.1 First Coat of Latex Blend
 - 3.5.2.2 Second Coat of Latex Blend
 - 3.5.2.3 Third Coat of Latex Blend and Reinforcing Fabric
 - 3.5.2.4 Extra Reinforcement Fabric at Bottom Ring Joint
 - 3.5.2.5 Finishing Coats of Latex Blend
- 3.6 MISCELLANEOUS METAL PRODUCTS
- 3.7 FIELD QUALITY CONTROL
 - 3.7.1 Tests of Lining Materials
 - 3.7.1.1 Package Stability
 - 3.7.1.2 Viscosity
 - 3.7.2 Test of Lining
 - 3.7.2.1 Adhesion Tests
 - 3.7.2.2 Thickness of Linings
 - 3.7.2.3 Pinholes
 - 3.7.3 Fill Test

-- End of Section Table of Contents --

```

*****
DEPARTMENT OF THE NAVY                NFGS-09980C
NAVAL FACILITIES                      30 September 1999
ENGINEERING COMMAND                   -----
GUIDE SPECIFICATION                   Superseding NFGS-09980B (09/98)
*****

```

NFGS-09980C

INTERIOR LINING FOR CONCRETE STORAGE TANKS (FOR PETROLEUM FUELS)

```

*****
*
* Preparing Activity: PACNAVFACENGCOM
*
*          Typed Name & Reg.          Signature          Date
*
* Prepared by: D. G. Tano, P.E.          /s/          01/20/98
*
* Approved by: W. T. Takushi, P.E.    /s/          01/20/98
*              Branch Manager
*
* Approved by: E. T. Takai, P.E.    /s/          01/20/98
*              Division Director
*
* Approved for NAVFAC: /s/          09/30/98
*                   Carl E. Kersten, R.A.
*
* Any changes or revisions to this document since the date of the
* original approval for NAVFAC, have been performed by the Guide
* Specifications Division (Code 15G).
*
* Changes or Revisions
* Approved for NAVFAC: /s/          09/30/99
*                   Carl E. Kersten, R.A.
*
*****

```

AMSC N/A

AREA FACR

```

*****
DEPARTMENT OF THE NAVY                                NFGS-09980C
NAVAL FACILITIES                                     30 September 1999
ENGINEERING COMMAND                                  -----
GUIDE SPECIFICATION                                 Superseding NFGS-09980B (09/98)
*****

```

SECTION 09980

INTERIOR LINING FOR CONCRETE STORAGE TANKS (FOR PETROLEUM FUELS)
09/99

```

*****
NOTE: This guide specification is intended to be
used in specifying the requirements for materials,
surface preparation, and methods of application of
epoxy primer, polysulfide/vinylidene chloride
copolymer latex blend with fabric reinforcement, and
precautions to safeguard health and safety while
lining concrete tanks for storage of petroleum
products. Patch tests should be performed on the
tank before a decision is made to initiate a project
to install the lining in a concrete tank. Contact
NAVFAC 04B3 if there is any doubt.
*****

```

```

*****
NOTE: This revision "C" to NFGS-09980 amends the
issue dated 30 September 1998 by revising the
submittal article to comply with the agreement
reached by the SPECSINTACT Tri-Agency Committee.
*****

```

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API PUBL 2015 (1994) Safe Entry and Cleaning of
Petroleum Storage Tanks

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 150 (1997) Portland Cement

ASTM C 881 (1990) Epoxy-Resin-Base Bonding Systems
for Concrete

ASTM D 562 (1981; R 1997) Consistency of Paints Using

the Stormer Viscometer

ASTM D 2369

(1997) Volatile Content of Coatings

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1000	Air Contaminants
29 CFR 1910.1018	Inorganic Arsenic
29 CFR 1910.1025	Lead
29 CFR 1910.1200	Hazard Communication
40 CFR 260	Hazardous Waste Management Systems: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Generators of Hazardous Waste
40 CFR 263	Transporters of Hazardous Waste
40 CFR 264	Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standard for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 266	Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
40 CFR 268	Land Disposal Restrictions

FEDERAL SPECIFICATIONS (FS)

FS CCC-C-429

(Rev. F) Cloth, Osnaburg, Cotton

FEDERAL STANDARDS (FED-STD)

FED-STD-141

(Rev. C) Paint, Varnish, Lacquer and
Related Materials: Methods of Inspection,
Sampling and Testing

MILITARY SPECIFICATIONS (MIL)

MIL-C-4556

(Rev. E) Coating Kit, Epoxy, for Interior
of Steel Fuel Tanks

MIL-A-22262

(Rev. B; Am. 2) Abrasive Blasting Media
Ship Hull Blast Cleaning

MIL-P-23236

(Rev. B; Am. 2) Paint Coating Systems,
Fuel and Salt Water Ballast Tanks (Metric)
STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC SP 5

(1994) White Metal Blast Cleaning

1.2 SUBMITTALS

NOTE: Where a "G" in submittal tags follows a
submittal item, it indicates Government approval for
that item. Add "G" in submittal tags following any
added or existing submittal items deemed
sufficiently critical, complex, or aesthetically
significantly to merit approval by the Government.
Submittal items not designated with a "G" will be
approved by the QC organization.

Submit the following in accordance with Section 01330, "Submittal
Procedures."

SD-03 Product Data

NRL formulation

Submit formulator's printed catalog data which include brand
names, catalog numbers, and names of manufacturers.

SD-06 Test Reports

NRL lining materials tests

Blasting abrasive tests

Tests of lining materials

Test of lining

Fill test

SD-07 Certificates

NRL formulation

SD-08 Manufacturer's Instructions

NRL formulation, include Material Safety Data Sheets (MSDS)

The instructions shall include detailed mixing and application
procedures, number and types of coats required, minimum and

maximum application temperatures, and curing procedures. In accordance with OSHA 29 CFR 1910.1200, obtain MSDS from the manufacturer for those products used or identified in this specification.

1.3 MATERIAL SAFETY

Ensure that employees are trained in the requirements of OSHA 29 CFR 1910.1200 and understand the information contained in the MSDS for their protection against toxic and hazardous chemical effects.

1.4 QUALITY ASSURANCE

1.4.1 Test Reports

1.4.1.1 Naval Research Laboratory (NRL) Lining Materials Tests

Submit laboratory test results for NRL lining materials in accordance with paragraph entitled "Sampling" for the second, and subsequent tests performed at the expense of the Contractor.

1.4.1.2 Blasting Abrasive Tests

Submit laboratory test results of blasting abrasive and certify conformance to contract requirements. Submit copies of test results required by MIL-A-22262 and certifications.

PART 2 PRODUCTS

2.1 BRAND NAME PRODUCTS

NOTE: The use of proprietary materials specified in this section has been approved by NAVFACENGCOMHQ (Code 0211) in accordance with the requirements of NAVFAC P-68. Paragraphs in this section may be used without any further NAVFACENGCOMHQ approval or request for waiver.

When this section specifies a brand name product, notwithstanding any other provision of this contract, no other product will be accepted.

2.2 CONCRETE REPAIR MATERIALS

2.2.1 Cement

ASTM C 150, Type I.

2.2.2 Abrasive

NOTE: Requirements are essential for OSHA and EPA compliance. Other abrasive materials may be

selected to suit local conditions.

2.2.2.1 New Abrasive

Abrasive for blasting shall be sharp, washed, salt-free angular, [crushed wet bottom boiler slag] [_____] free from feldspar or other constituents that tend to break down and remain on the surface. Abrasive shall not contain magnetic materials and shall conform to MIL-A-22262, except that Mohs' hardness shall be 7 to 9 [and [_____]].

2.2.2.2 Recycled Abrasive

Screen and air wash abrasive recycled at the job site to remove dirt and fines. Add new abrasive so that the combined new and recycled abrasive mixture meets specified abrasive requirements for moisture, friability, silica, anchor pattern, and oil content. Do not recycle abrasive which has picked up toxic or hazardous material. Do not recycle nickel slag.

2.2.3 Water

For mixing, use potable water which is clean and free from injurious amounts of oil, acid, salt, alkali, organic matter, and other deleterious substances.

2.2.4 Mortar

NOTE: Select the applicable paragraph(s) from the following:

[Nonshrinking cement mortar, commercially prepared, premixed and used in accordance with manufacturer's instructions.]

[Epoxy-resin mortar consisting of an epoxy-resin binder conforming to ASTM C 881, Type III, except mineral filler shall not be used, but mix the epoxy-resin mortar with clean, dry, and sharp sand. Vary proportion of sand to epoxy-resin binder from three to seven parts of sand to one part binder depending on grade and size of sand used. Carry out small trial batches to determine proper proportions before preparing larger field batches. Prepare epoxy-resin binder first and add sand while continuously mixing until all particles are coated. Use moderately rich epoxy-resin mortar for cracks, and knife or press into voids as far as possible. When placing in larger open-type cavities, use a slightly leaner mix and prime existing surface first with a thin coating of straight epoxy-resin binder. Finish new mortar neatly and evenly with adjacent concrete surfaces. Remove excess material so that it is not thinly spread on adjacent concrete. If depth of area being repaired is over 50 mm 2 inches, make repair in not over 50 mm 2 inch layers. Allow each layer to set until peak temperature is past and has reduced to less than 60 degrees C 140 degrees F before applying another layer.]

2.3 EPOXY PRIMER MIXTURE

NOTE: The use of proprietary materials specified in this section has been approved by NAVFACENGCOMHQ (Code 0211) in accordance with the requirements of NAVFAC P-68. Paragraphs in this section may be used without any further NAVFACENGCOMHQ approval or request for waiver.

Provide a mixture of the following components:

- a. 1 Part by volume reactive aqueous amidoamine resin
- b. 1 Part by volume reactive epoxy resin emulsion

2.3.1 Products for Epoxy Primer

Materials shall be Durakote Epoxy Primer for Concrete, Parts A and B, as supplied by Chem-Masters, 477 Industrial Parkway, Chagrin Falls, OH 44022. The products are supplied in a 10-gallon kit consisting of 5-gallon quantities of each component.

2.4 NRL FORMULATION TLL-46

NOTE: The use of proprietary materials specified in this section has been approved by NAVFACENGCOMHQ (Code 0211) in accordance with the requirements of NAVFAC P-68. Paragraphs in this section may be used without any further NAVFACENGCOMHQ approval or request for waiver.

NOTE: Polysulfide latex, WD-6, is produced in quantities of 13,600 kg 30,000 pounds (60 drums) or more; ie., where the total surface area to be lined amounts to 19 500 square m 210,000 square feet or more. If smaller quantities are required, inquiries should be addressed to supplier. 3.8 L One gallon of NRL Formulation TLL-46 covers 2.3 plus or minus 0.1 square m 25 plus or minus one square foot of concrete surface with the full latex lining system.

Provide homogeneous blended latex, NRL Formulation TLL-46, which consists of polysulfide latex and vinylidene chloride copolymer latex which has been processed as specified below. Latex blend shall be smooth and paint-like when applied. Prior to application, do not subject blended latex to temperatures less than 4 degrees C nor more than 43 degrees C 40 degrees F nor more than 110 degrees F. Make NRL Formulation TLL-46 in accordance with the following formula:

<u>Material</u>	<u>Weight (kg)</u>	<u>Volume (L)</u>
Polysulfide latex WD-6 (75 percent nonvolatile)	165.0	127.76
Hydroxypropyl methyl cellulose (Methocel)	0.8	0.64
Water	40.4	40.50
Vinylidene chloride copolymer latex	247.5	201.35
Diethylene glycol monoethyl ether acetate	7.4	7.38
2-n-octyl-4-isothiazolin-3-one (Skane M-8)	0.9	0.91
<hr/>		
Total	462.0	378.54

<u>Material</u>	<u>Weight (Pounds)</u>	<u>Volume (Gallons)</u>
Polysulfide latex WD-6 (75 percent nonvolatile)	363.8	33.75
Hydroxypropyl methyl cellulose (Methocel)	1.8	0.17
Water	89.15	10.70
Vinylidene chloride copolymer latex	545.7	53.19
Diethylene glycol monoethyl ether acetate	16.37	1.95
2-n-octyl-4-isothiazolin-3-one (Skane M-8)	2.00	0.24
<hr/>		
Total	1,018.82	100.00

2.4.1 Polysulfide Latex, WD-6

NOTE: Polysulfide latex, WD-6, is produced in quantities of 13,600 kg 30,000 pounds (60 drums) or more; ie., where the total surface area to be lined amounts to 19 500 square m 210,000 square feet or more. If smaller quantities are required, inquiries should be addressed to supplier. 3.8 L One gallon of NRL Formulation TLL-46 covers 2.3 plus or minus 0.1 square m 25 plus or minus one square foot of concrete surface with the full latex lining system.

Polysulfide latex shall be an aqueous dispersion of "WD-6" manufactured by Morton Chemical Co. Polysulfide latex shall have a nonvolatile content of not less than 75 percent by weight when tested in accordance with ASTM D 2369. Polysulfide latex shall readily mix to a smooth, homogeneous state and shall show no skinning, livering, curdling, hard settling or caking that cannot be mixed to a smooth, homogeneous state, when tested as specified in accordance with Method 3011.2 of FED-STD-141. Obtain sufficient polysulfide latex to meet requirements for complete lining system as specified in paragraph entitled "Tank Lining." Follow information on label of material for use as well as for transportation and storage.

2.4.2 Hydroxypropyl Methyl Cellulose

 NOTE: The use of proprietary materials specified in this section has been approved by NAVFACENGCOMHQ (Code 0211) in accordance with the requirements of NAVFAC P-68. Paragraphs in this section may be used without any further NAVFACENGCOMHQ approval or request for waiver.

Dow Chemical Company product known as "Methocel," Type 65HG, Premium Grade, 4,000 CPS.

2.4.3 Vinylidene Chloride Copolymer Latex

 NOTE: The use of proprietary materials specified in this section has been approved by NAVFACENGCOMHQ (Code 0211) in accordance with the requirements of NAVFAC P-68. Paragraphs in this section may be used without any further NAVFACENGCOM HQ approval or request for waiver.

Use aqueous dispersion of a Chem-Masters Corporation, Chagrin Falls, OH 44022, product designated as Polychem No. 4652, which meets the characteristics given in Table I. Use vinylidene chloride copolymer that is not more than 90 days old when received by coatings formulator.

Table I. - Characteristics of Vinylidene Chloride Copolymer Latex

<u>Characteristic</u>	<u>4652</u>	
	<u>Value</u>	<u>Tolerance*</u>
Solids content, percent by weight	50	1
Specific gravity at 25 degrees C	1.25	0.01
Weight per liter of latex, kilograms	5.94	0.06
pH	6.0	1.0
Particle size of miscelles, Angstroms	1400	100

*Tolerance is expressed as plus or minus value given.

Table I. - Characteristics of Vinylidene Chloride Copolymer Latex

4652

<u>Characteristic</u>	<u>Value</u>	<u>Tolerance*</u>
Solids content, percent by weight	50	1
Specific gravity at 25 degrees C	1.25	0.01
Weight per gallon of latex, pounds	10.19	0.10
pH	6.0	1.0
Particle size of miscelles, Angstroms	1400	100

*Tolerance is expressed as plus or minus value given.

2.4.4 Diethylene Glycol Monoethyl Ether Acetate

NOTE: The use of proprietary materials specified in this section has been approved by NAVFACENGCOMHQ (Code 0211) in accordance with the requirements of NAVFAC P-68. Paragraphs in this section may be used without any further NAVFACENGCOMHQ approval or request for waiver.

Use either "Carbitol" acetate manufactured by Union Carbide Corporation or "Ektasolve DE" acetate manufactured by Eastman Chemical Products, Inc.

2.4.5 2-N-Octyl-4-Isothiazolin-3-One

Use a product known as "Skane M-8" manufactured by Rohm and Haas Company, which carries EPA registration number 707-100.

2.5 INSTRUCTIONS FOR MIXING NRL FORMULATION TLL-46

Speed of mixer shall not exceed 1400 rpm. Permit no vortexing, foaming, or excess shearing action during mixing of thickener or latexes. Use a Double Planetary Change Can Mixer, which has stirrers with close clearance between sides and bottom of can to make it impossible for unmixed material to accumulate on sides or bottom. Other types of mixers are satisfactory provided the specified requirements are met. With other types of low-speed mixers, frequent removal of unmixed material from the walls and bottom of the container by hand scraping is required. Do not use high-speed dispersers, paint mills, and similar mixing equipment, used for dispersing pigments by shear or impingement. Directions for preparing a 378.5 L 100 gallon batch are specified in the paragraphs entitled "Thickener" and "Latex Lining." For experimental purposes, the same weights in grams

instead of pounds makes approximately one quart of NRL Formulation TLL-46.

2.5.1 Thickener

The first step in preparing lining material is to make a thickener solution. Prepare thickener as follows: Weigh 0.8 kg 1.8 pounds of hydroxypropyl methyl cellulose powder into a 60 L 15 gallon minimum volume mixer. While stirring, add 7.4 kg 16.4 pounds of diethylene glycol monoethyl ether acetate. Continue stirring until hydroxypropyl methyl cellulose is dispersed. To this dispersion add 40.4 kg 89.15 pounds of water (demineralized if available) at a rate where thickening occurs without formation of lumps. After all water has been added and mixture is homogeneous, very slowly add 0.9 kg 2 pounds of 2-n-octyl-4-isothiazolin-3-one. Continue stirring until thickener mixture is homogeneous. Final volume of this thickener is 49.4 L (49.6 kg) 13.06 gallons (109.35 pounds).

2.5.2 Latex Lining

NOTE: Polysulfide latex, WD-6, is produced in quantities of 13,600 kg 30,000 pounds (60 drums) or more; ie., where the total surface area to be lined amounts to 19 500 square m 210,000 square feet or more. If smaller quantities are required, inquiries should be addressed to supplier. 3.8 L One gallon of NRL Formulation TLL-46 covers 2.3 plus or minus 0.1 square m 25 plus or minus one square foot of concrete surface with the full latex lining system.

The procedure for preparing a 378.54 L 100 gallon batch of NRL Formulation TLL-46 lining is as follows: Weigh 165.0 kg 363.8 pounds of polysulfide latex, WD-6, into slow-speed mixer having a minimum volume of 450 L 110 gallons. This latex may sometimes be in a damp, lumpy solid condition but will readily disperse in water with stirring, forming a liquid latex of 50 percent nonvolatile content or lower. To the WD-6, add 46.6 kg 109.2 pounds of thickener, mixed in accordance with the paragraph entitled "Thickener," while stirring at a rate as necessary to maintain a heavy paste-like consistency free of any lumps. Continue stirring and add 247.5 kg (201.4 L) 545.7 pounds (53.2 gallons) of vinylidene chloride latex copolymer in 4 approximately equal increments at a rate such that each increment is thoroughly blended before next increment is added. Continue stirring until final latex lining material is thoroughly blended and is of a somewhat thixotropic, creamy consistency. Upon filling into containers, strain final latex lining material through a suitable strainer such as insect screen to remove skins, lumps, or foreign matter. Final product viscosity is about 60 plus or minus 3 K.U. at 70 degrees F 21 degrees C as measured with a Krebs-Stormer Viscometer.

2.6 REINFORCING FABRIC

In conjunction with NRL Formulation TLL-46 blended latex, provide reinforcing fabric cotton Osnaburg conforming to FS CCC-C-429, Type II,

Class 5, width not more than 1200 mm 48 inches. Weight of fabric shall not exceed 152.5 grams per square meter 4.5 ounces per square yard.

2.7 EPOXY COATING FOR MISCELLANEOUS METAL

NOTE: Epoxy coatings listed are suitable for use in aviation fuel storage tanks. Delete if not used. See also the paragraph entitled "MISCELLANEOUS METAL PRODUCTS."

MIL-C-4556 or MIL-P-23236, two coats minimum coating system.

2.8 SOURCE QUALITY CONTROL

2.8.1 Sampling

Notify the Contracting Officer when lining material is available for sampling at site or source of supply. When directed by Contracting Officer, the Contractor, in the presence of the Government representative will obtain a one-quart random sample from each batch of sealed containers.

Accomplish adequate mixing prior to sampling to ensure a uniform, representative sample. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Clearly identify samples by designated name, specification number, batch number, project contract number, intended use, and quantity involved. The Government will ship and test samples.

2.8.2 Tests

Select test samples in accordance with applicable material specifications. The Government will bear cost of first test. If a sample fails to meet specification requirements, replace material represented by the sample, and retest.

PART 3 EXECUTION

3.1 PROTECTION FROM TOXIC AND HAZARDOUS CHEMICAL AGENTS

NOTE: Include OSHA 29 CFR 1910.1018 for arsenic exposure and OSHA 29 CFR 1910.1025 for lead exposure.

During tank cleaning, cleanup, surface preparation, and lining application phases, ensure that employees are adequately protected from toxic and hazardous chemical agents which exceed the concentrations in OSHA 29 CFR 1910.1000 [, OSHA 29 CFR 1910.1018, and OSHA 29 CFR 1910.1025]. Comply with respiratory protection requirements in OSHA 29 CFR 1910.134.

3.1.1 Certified Industrial Hygienist (CIH)

Obtain the services of an industrial hygienist certified by the American

Board of Industrial Hygiene to review and approve the operations as to correctness of work procedures and personal protective equipment.

3.2 VENTILATION AND AMBIENT CONDITIONS

Provide forced ventilation inside tanks throughout course of work as required to maintain a vapor-free condition. Use exhaust fans, either explosion-proof electrically operated or air-driven. Fans shall have sufficient capacity to hold vapor concentration below 10 percent of lower explosive limit as determined with an approved explosive meter. Keep fans in operation whenever workmen are in tanks and as long as may be necessary for proper cure of coatings. Ambient conditions shall be such that each coat of latex blend dries (cures) within 8 hours. When combination of ambient temperature and humidity is such that this rate of drying (curing) cannot be obtained, suspend work and utilize space heating, dehumidification, and additional ventilating equipment to secure specified rate of drying and curing. Temperature and relative humidity shall be maintained within the range recommended by the manufacturer of the product being cured. Ventilation shall meet at least minimum safety requirements appropriate to thinners or chemicals used. During application of primer and lining system, provide a minimum of 10 air changes per hour. Where this is not feasible due to size of tank or limitations in number and size of manhole openings, provide suction ductwork extending to areas of heaviest concentrations including lowest levels of tank. In no case shall exhaust fan capacity be less than 4800 L/s 10,000 cfm except for small tanks of 950 kL 250,000 gallons or less. Ventilate tanks thoroughly during abrasive blasting and during application and drying (curing) of lining.

3.3 TANK CLEANING SAFETY, FUEL REMOVAL, AND SAFETY AFTER CLEANING

NOTE: Include the last sentence for tanks with lead hazard.

Cleaning of storage tanks, ventilation, fuel removal, and safety, shall be in accordance with Section 13219, "Cleaning Petroleum Storage Tanks." [API PUBL 2015 cautions that concrete tanks cannot be rendered lead-hazard free.]

3.4 SURFACE PREPARATION

NOTE: The use of proprietary materials specified in this section has been approved by NAVFACENGCOMHQ (Code 0211) in accordance with the requirements of NAVFAC P-68. Paragraphs in this section may be used without any further NAVFACENGCOMHQ approval or request for waiver.

Clean surfaces to be lined and free them from dust and fuel contamination. Completely remove entire existing lining from previously lined tanks. Use a suitable detergent such as an oil-soluble type, GSA Stock No. 7930-00-531-9715 or 7930-00-958-6033 at a concentration of 5 fluid ounces

per gallon of petroleum solvent such as kerosene, high flash naphtha, or JP-5. Both GSA Stock No. detergents are available from Chemscope Corporation, 3200 East Randol Mill Road, Arlington, Texas 76011. When patching existing linings, completely remove defective or loosely adhering areas. Cut back failures at least 150 mm 6 inches beyond affected areas. When lining new concrete tanks, etch surfaces, after cleaning, with a 10 percent aqueous hydrochloric acid solution and wash sufficiently with clean water to remove all traces of acid solution. Acid solution etching will not be required for older existing tanks. Clean and abrasive blast concrete containing absorbed oils or fuel residues such that adhesion tests meet requirements specified in the paragraph entitled "Patch Tests."

3.4.1 First Abrasive Blast

After cleaning, give surfaces to be lined a first abrasive blast sufficient to remove remaining traces of oil. Use conventional air, force-feed, or pressure-type blasting equipment. Water or vapor blast is not permitted. Use nozzle of such size that a pressure of 620.5 plus or minus 69 kPa 90 plus or minus 10 psig is maintained at blast generator. Provide filtered and dried air supply. After abrasive blasting, thoroughly clean surfaces by brushing, blowing with compressed air, or vacuuming. Remove dirt and abrasive from tank and dispose of the material in accordance with applicable regulations. Perform toxicity tests required to comply with environmental regulations at no additional cost to the Government.

3.4.2 Concrete Repairs

Following cleaning and first abrasive blasting, carefully inspect concrete surfaces for defects. Remove loose or unsound concrete by chipping back to clean solid concrete. Pack surface spalls, tie holes, construction joints, voids, or other concrete imperfections over 10 mm wide by 6 mm and lineal cracks over 2 mm wide 3/8 inch wide by 1/4 inch deep and lineal cracks over 1/32 inch wide, regardless of length, with mortar specified in paragraph entitled "Mortar" flush with surface of concrete. Chip out places where oil back-seepage is continuous to a depth of at least 13 mm 1/2 inch and quickly pack with mortar to seal off oil flow. Grind-off fins, sharp offsets, and other concrete surface projections, or fill with mortar and trowel smooth, so that a smooth finish is obtained. Where the surface of the concrete has been repaired with mortar, etch with acid solution and then wash as specified in the paragraph entitled "Surface Preparation."

3.4.2.1 Estimated Area

NOTE: Estimate areas to be repaired by concrete patching. These areas are difficult to define and only by mutual agreement between the Contractor and Contracting Officer can a realistic estimate be established. The following is offered to assist in establishing the concrete patching to be done:

- 1. Cracks: Cracks to be repaired should be estimated to the nearest square meter foot; for example, 25 mm wide by 36000 mm one inch wide by 12**

feet long equals one square meter one square foot. However, the actual area could vary appreciably depending on the type of crack.

2. Spalls less than 160 mm 6 inches: Areas containing spalls could be so numerous that the area could be estimated as a patch and could lead to an inflated estimate. Isolated spalls should be estimated on actual area to be repaired; others should be considered as patches.

3. Patches less than 6 mm 1/4 inch deep: Patches less than 6 mm 1/4 inch deep should be estimated as a regular patch if subsequent tank lining operations result in damage to the lining caused by the uneven substance.

Total area of concrete repairs, including holes, cracks, depressions and patching of oil seeps, is estimated to be [_____] square meters feet.

3.4.3 Cove and Corner Chamfering

Provide cove at the bottom ring joint; that is, where tank wall meets tank bottom. Remove existing cove material and clean joint until sides expose fresh original concrete. Flush thoroughly exposed concrete and bottom of joint with water having a temperature not exceeding 54 degrees C 130 degrees F, and blow loose particles out of joint with compressed air. Repack joint with mortar specified in paragraph entitled "Mortar" and form a cove of mortar between floor and wall. Cove shall have a 45-degree face and minimum 75 mm 3 inch sides. Provide same type of cove at intersection of columns and base, base and floor, and inside corners of sumps. Provide mortar cove around pipes, sleeves, and manholes passing through tank wall or floor. Chamfer inverse corners to a minimum radius of 12 mm 1/2 inch.

3.4.4 Patch Tests

3.4.4.1 General

Concurrent with concrete repairs and not more than 2 days after completion of first abrasive blast, apply test patches of lining system for adhesion determinations to ensure adequate surface preparation and proper ventilation and ambient conditions for drying. Perform patch tests. Inform the Contracting Officer, in sufficient time, so that the Contracting Officer may witness these tests.

3.4.4.2 Test Preparation

Apply at least six patches, two on floor, and four on wall, at locations designated by Contracting Officer. Make each test patch approximately 300 mm 12 inches square and prepare in identical manner as a complete lining system specified in paragraph entitled "Tank Lining." Allow patches to cure for not less than 3 days nor more than 7 days before performing adhesion tests.

3.4.4.3 Tests

Using a razor blade or sharp knife, accurately make two parallel cuts through lining, 25 mm one inch apart, for a length of about 250 mm 10 inches.

Take a minimum of three strips per patch. Peel one end of resulting strip of lining from concrete for a length sufficient to permit its attachment to a calibrated spring-type scale or similar device capable of measuring pounds of pull required to peel off a minimum of 150 mm 6 inches of strip. The device shall peel back strip of lining at a rate of approximately 25 mm one inch per second. Exert pulling force at angle between 85 and 95 degrees. Pull shall average 22 N 5 pounds or higher. Less than 22 N 5 pounds pull indicates inadequate surface preparation, allowing epoxy primer to become too hard before applying latex blend, improper temperature and humidity conditions, or improper mixing of the NRL Formulation TLL-46.

3.4.4.4 Approval

If average pull is less than 22 N 5 pounds, reclean surface, adjust ambient conditions if warranted, alter formulation if necessary, and repeat patch tests as part of work. Do not commence complete lining system until patch tests meet specified requirements and Contracting Officer has given approval.

3.4.5 Second "Brush" Abrasive Blast

NOTE: The second "brush" abrasive blast is intended for tanks that have contained black oil. This second "brush" abrasive blast may be omitted when this is not the case, such as is often true for tanks which have contained highly volatile products (gasoline) or for new tanks. However, the requirement to "brush" abrasive blast the surfaces of the new epoxy-resin mortar where used for concrete repairs and coves shall be included in all cases. As an alternate to "brush" abrasive blasting the freshly applied and cured epoxy-resin mortar, light hand sanding to roughen these surfaces, prior to application of the lining system, may be specified. If non-shrinking cement mortar is used for concrete repairs and coves, a wood-trowelled finish may be specified to provide the necessary "tooth" in lieu of abrasive blasting or hand sanding.

Following completion of the concrete repairs, installation of coves, and approval of the patch tests, give a second "brush" abrasive blast to concrete surfaces to be lined. Abrasive blast and cleanup as specified in paragraph entitled "First Abrasive Blast." This second "brush" abrasive blast shall remove oil back-seepage, remaining fuel residue, and remaining patch test material from surface. The second abrasive blast also shall provide a "tooth" or an anchor pattern of one to 0.5 mm 2 mils over entire concrete surface and shall roughen surfaces of new epoxy-resin mortar used

for concrete repairs and coves to provide required adhesion of lining system.

3.4.6 Disposal of Used Abrasive

Test used abrasive in accordance with 40 CFR 261 to determine if it is a hazardous waste using the EP toxicity test for metals. Handle and dispose of abrasive determined to be hazardous waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, 40 CFR 266, and 40 CFR 268. Dispose of abrasive which is not hazardous waste at a landfill off Government property in accordance with applicable regulations. The contract price will be adjusted if the used abrasive is determined to be hazardous waste. However, payment for disposal of hazardous waste will not be made until a completed manifest from the treatment or disposal facility is returned, and a copy furnished to the Government.

3.5 TANK LINING

Line entire tank bottom and walls. Line columns to 450 mm 18 inches above floor, and coat remainder of columns up to tank roof only with epoxy primer and two coats of latex blend.

3.5.1 Epoxy Primer

Begin application of lining system as soon as possible after completing second abrasive blast. In no case shall time interval between completion of abrasive blasting and commencement of the epoxy primer application exceed 2 days. Coat surfaces to be lined first with an aqueous amidoamine epoxy resin primer. Mix three components of this primer only in amounts needed to cover an area to which first coat of latex blend can be applied the following day. Add water in increments not exceeding those requirements specified in the paragraph entitled "Epoxy Primer Mixture" but as needed to maintain a workable viscosity over period of application. The mixture thickens on standing. Maintain viscosity so as to provide a minimum of sagging or running on vertical surfaces. Apply primer by brush or roller and work well into voids in the surface. Spread primer as uniformly as possible to a thickness of 0.2 to 0.25 mm 8 to 10 milswet. Coverage is approximately 4 to 5 square meters per liter 160 to 200 square feet per gallon. Apply first coat of NRL Formulation TLL-46 latex blend after a drying period of 12 hours, but not exceeding 30 hours. If any primed area exceeds a drying period of 30 hours or if the primer is no longer tacky, apply an additional coat of primer over first coat prior to application of first coat of latex blend. Apply the first coat of latex blend while primer is still tacky.

3.5.2 Latex Blend Lining System Application

NOTE: Polysulfide latex, WD-6, is produced in quantities of 13,600 kg 30,000 pounds (60 drums) or more; ie., where the total surface area to be lined amounts to 19 500 square m 210,000 square feet or more. If smaller quantities are required, inquiries should be addressed to supplier. 3.8 L One gallon

of NRL Formulation TLL-46 covers 2.3 plus or minus
0.1 square m 25 plus or minus one square foot of
concrete surface with the full latex lining system.

First apply lining system, including reinforcing fabric, to walls and columns and then to floor and sumps. When patching existing linings, new patches shall overlap existing lining around the stripped area by at least 200 mm 8 inches. Apply latex blend uniformly by brush or roller. Each coat may be laid down to a 0.25 mm 10 mil, wet-film thickness which will result in a dry film thickness of approximately 0.12 mm 5 mils.

3.5.2.1 First Coat of Latex Blend

Apply first coat uniformly to epoxy-primer-treated concrete surface while epoxy primer is still tacky. Work first coat of latex into surface and allow to set. Drying time shall not exceed 8 hours as specified in paragraph entitled "Ventilation and Ambient Conditions."

3.5.2.2 Second Coat of Latex Blend

Apply second coat uniformly over first coat after it has set. Drying time shall not exceed 8 hours.

3.5.2.3 Third Coat of Latex Blend and Reinforcing Fabric

Apply reinforcing fabric in third coat of latex blend. Wash fabric with laundry detergent to remove fireproofing chemicals and sizing, if present, and rinse thoroughly to remove detergent. If fabric is not used immediately after washing, dry fabric completely for storage. When dry fabric is used, thoroughly wet fabric with clean potable water and wring out to a damp condition at time of application. In no case apply fabric dry nor soak fabric in latex blend prior to application. After second coat of latex blend has set, uniformly apply a third coat. While latex is still wet, press wetted fabric immediately onto surface and smooth out with a dry brush. As soon as fabric has been straightened and wrinkles worked out, apply another coat of latex blend to ensure the fabric is entirely covered with latex. Dampening of fabric assists in drawing wet latex into and around each strand of fiber as well as preshrinking fabric. Apply reinforcing fabric in strips with edge of each strip overlapping the other by at least 50 mm 2 inches. Extend overlaps at corners, such as between floor and wall and between floor and columns, not less than 200 mm 8 inches onto floor, nor less than 200 mm 8 inches up the walls and columns. Apply wall strips horizontally or vertically. Stop these strips 150 mm 6 inches below tank roof. Seal top edge of fabric against concrete by applying latex blend at least 150 mm 6 inches above edge of fabric.

3.5.2.4 Extra Reinforcement Fabric at Bottom Ring Joint

While third coat of latex blend is still wet, press an additional width of damp reinforcing fabric into place around bottom ring joint and smooth out with a dry brush. Fabric shall extend at least 250 mm 10 inches onto the floor and 350 mm 14 inches or more up wall. Apply another coat of latex blend on top of this second piece of reinforcing fabric to ensure the

fabric is entirely covered with latex. Allow latex blend from third coat with extra reinforcing fabric at bottom ring joint to set before applying finishing coats.

3.5.2.5 Finishing Coats of Latex Blend

Finishing coats shall consist of three or more full coats of latex blend as necessary to achieve a total dry-film thickness of not less than one mm 40 mils. Allow each coat to dry before next coat is applied. Apply coats smoothly and uniformly. Since thick ridges of coating material take longer to cure, these ridges are not allowed. Following application of final coat of latex blend, at least 14 days shall elapse before placing tank in service or fill testing with fuel.

3.6 MISCELLANEOUS METAL PRODUCTS

NOTE: The epoxy coatings are suitable for use in aviation fuel storage tanks.

Perform white metal abrasive blasting in accordance with SSPC SP 5 on miscellaneous metal products, such as ladders and standpipes, and apply epoxy coating conforming to MIL-C-4556 or MIL-P-23236.

3.7 FIELD QUALITY CONTROL

As an exception to requirements that may be stated elsewhere in this contract, make tests and inspections under direction of, and subject to approval of, the Contracting Officer.

3.7.1 Tests of Lining Materials

3.7.1.1 Package Stability

Determine package stability by observing the blended latex for lumps, cakes, or gels that cannot be redispersed readily by stirring with a wooden paddle, just prior to application of the blended latex (NRL Formulation TLL-46) without addition of a thinner or diluent. Redispersed emulsion is suitable for brush application. After application, examine the brushed film to ensure homogeneity, smoothness, and freedom from voids, coarse particles and cracks. If the brushed film does not pass the examination for coating appearance and integrity, then one or more of the coating constituents has exceeded its shelf-life and shall be replaced.

3.7.1.2 Viscosity

Determine viscosity of NRL Formulation TLL-46, blended latex, with a Stormer Viscometer in accordance with ASTM D 562.

3.7.2 Test of Lining

3.7.2.1 Adhesion Tests

Following completion and cure of complete lining system, carry out adhesion tests. Adhesion tests shall be made in the same manner as that specified in the paragraphs entitled "Patch Tests," "Test Preparation," and "Tests." Perform the adhesion tests. Inform the Contracting Officer, in sufficient time, so that the Contracting Officer may witness these tests.

- a. Take a total of six pull tests, four on the wall and two on the floor. Pulls shall average 22 N 5 pounds or more.
- b. Approval: Unsatisfactory adhesion is cause for rejection, removal, and reapplication of lining system.
- c. Repair: Following the adhesion tests, apply patches over stripped areas, overlapping 200 mm 8 inches all around. Make patches identical to specified lining system.

3.7.2.2 Thickness of Linings

Determine thickness of linings by measuring with suitable calipers or micrometer. Take thickness measurements from 25 mm one inch wide-strips of lining removed during adhesion tests. Remove layers in order to obtain correct thickness of lining.

3.7.2.3 Pinholes

Determine pinholing by close visual inspection of completed lining. Repair pinholes by applying at least three additional coats of latex to pinholed areas.

3.7.3 Fill Test

After the work has been inspected and approved, fill test the tank. Allow a cure time of at least 14 days after the final coat has been applied before carrying out the fill test. Remove the blind flanges and reconnect tank piping ready for service. [Reinstall the liquid level gaging float.] The Government will provide the necessary fuel and labor to fill the tank with fuel. Advise the Contracting Officer, in writing, at least 10 days in advance of the need for this service. Fill tank half full [and check that drain valves are closed] and check tank for leaks. Keep tank half full the first 12 hours of test, then fill tank to full capacity, [and check that drain valves are closed] and check tank for leaks. Monitor tank level hourly during the first 24 hours of the fill test and notify the Contracting Officer immediately of leaks detected. [Padlock drain valves closed for the duration of the test and provide one set of keys to the Contracting Officer.] After the temperature of the fuel has become stabilized, take daily readings of the fuel level for a period of 10 days. If there is no measurable drop in the fuel level during this period, the tank will be accepted. If leakage becomes apparent during the filling or the test period, immediately notify the Contracting Officer, and Government personnel will pump the fuel from the tank. Free the tank of vapor, clean it, and then carefully inspect the new coating system for evidence of failures. Repair defects found and repeat fill tests.

NOTE: Suggestions for improvement of this specification will be welcomed using the Navy "Change Request Forms" subdirectory located in SPECSINTACT in Jobs or Masters under "Forms/Documents" directory or DD Form 1426. Suggestions should be forwarded to:

Commander
Naval Facilities Engineering Command
Engineering Innovation and Criteria Office, Code EICO
1510 Gilbert Street
Norfolk, VA 23511-2699

FAX: (757) 322-4416 or
Email: cgs@efdlant.navfac.navy.mil

-- End of Section --